

WE CLAIM THE FOLLOWING:

1. A digital data transmitting system using an acoustic tone, the system comprising:

a generator for generating digital data bits, said digital data bits including at least one check bit;

an error correction and interleaving system for adding at least one error correction bit to the digital data bits to form a data sequence;

an encoder for encoding each bit in the data sequence with a signal having the at least one acoustic tone to form an encoded sequence, the frequency of the at least one tone lying between 20Hz and 20kHz; and

an audio speaker for transmitting the encoded sequence.

2. The digital data transmitting system according to claim 1, further including a modulator having a carrier signal as one of its input, said carrier signal being modulated by the encoded sequence.

3. The digital data transmitting system according to claim 1, wherein the number of digital data bits is the same as the number of error correction bits.

4. The digital data transmitting system according to claim 1, wherein the number of digital data bits is an integer multiple of P.

5. The digital data transmitting system according to claim 4, wherein $P=3$.

6. The digital data transmitting system according to claim 1, wherein each bit in the data sequence is encoded with a signal having two frequencies.

7. The digital data transmitting system according to claim 6, wherein the signal comprises a tone of a first frequency, followed by a first silence period, followed by a tone of a second frequency, and followed by a second silence period.

8. The digital data transmitting system according to claim 7, wherein the first frequency is substantially about 1600 Hz and the second frequency is substantially about 2800 Hz when the bit is a 0.

9. The digital data transmitting system according to claim 7, wherein the first frequency is substantially about 2800 Hz and the second frequency is substantially about 1600 Hz when the bit is a 1.

10. The digital data transmitting system according to claim 7, wherein the first and the second silence period is about 20 ms in duration.

11. The digital data transmitting system according to claim 1, wherein the data sequence 18 bits long.

12. The digital data transmitting system according to claim 2, wherein the modulator system is an amplitude modulator.

13. A method for transmitting digital data using acoustic tones, the method comprising:

generating digital data bits, said digital data bits including at least one check bit;

adding at least one error correction bit to the digital data bits to form a data sequence;

encoding each bit in the data sequence with a signal having at least one tone to form an encoded sequence, the frequency of the at least one tone lying between 20Hz and 20kHz; and

transmitting the encoded sequence by an audio speaker.

14. The digital data transmitting system according to claim 1, further including the step of modulating a carrier signal by the encoded sequence by means of a modulator system.

15. The digital data transmitting system according to claim 13, wherein the number of digital data bits is the same as the number of error correction bits.

16. The digital data transmitting system according to claim 13, wherein each bit in the data sequence is encoded with a signal having two frequencies.

17. The digital data transmitting system according to claim 16, wherein the signal comprises a tone of a first frequency, followed by a first silence period, followed by a tone of a second frequency, and followed by a second silence period.

18. The digital data transmitting system according to claim 17, wherein the first frequency is substantially about 1600 Hz and the second frequency is substantially about 2800 Hz when the bit is a 0.

19. The digital data transmitting system according to claim 17, wherein the first frequency is substantially about 2800 Hz and the second frequency is substantially about 1600 Hz when the bit is a 1.

20. The digital data transmitting system according to claim 17, wherein the first and the second silence period is about 20 ms in duration.

21. The digital data transmitting system according to claim 13, wherein the data sequence 18 bits long.

22. The digital data transmitting system according to claim 14, wherein the modulator system is an amplitude modulator.

23. A receiver for detecting digital data in an acoustic tone based signal, the receiver comprising:

a first and a second set of filters for filtering the received acoustic tone based signal;

a first and a second detector for determining the magnitude of the complex domain output from the first and the second set of filters respectively;

a difference operator for generating a difference between a transformed output from the first detector and a transformed output from the second detector at an output of said difference operator;

means for detecting a digital word, said digital word obtained from a bit detector, wherein the input to the bit detector is the output of said difference operator;

a buffer for storing the detected digital word; and

means for error correcting the stored digital word for determining the digital data.

24. The receiver according to claim 23, wherein the first set of filters includes an in-phase filter and a quadrature filter.

25. The receiver according to claim 23, wherein the second set of filters includes an in-phase filter and a quadrature filter.

26. The receiver according to claim 23, further including a first and a second p-bit delay operators, the first p-bit delay operator delaying the output from the first detector and the second p-bit delay operator delaying the output from the second detector.

27. The receiver according to claim 26, wherein $p=1/2$.

28. The receiver according to claim 26, further including a first and a second difference means for transforming the outputs from the first and the second detectors.

29. The receiver according to claim 28, wherein the first difference means determines the difference between the output of the first detector and an output of the first p-bit delay operator.

30. The receiver according to claim 28, wherein the second difference means determines the difference between the output of the second detector and an output of the second p-bit delay operator.

31. The receiver according to claim 23, further including means for determining a score as a function of previous values of the difference between the outputs of the first and the second detectors.

32. The receiver according to claim 31, wherein the stored digital word is selected for error correction if the score for said stored digital word exceeds a threshold.

33. The receiver according to claim 31, wherein the score is a sum of the previous values of the difference between the outputs of the first and the second detectors.

34. The receiver according to claim 32, further including means for dynamically adjusting the threshold as a function of an unselected digital word.

35. A method for detecting digital data in an acoustic tone based signal, the method comprising:

filtering the received acoustic tone based signal by a first and a second set of filters;

determining the magnitude of the complex domain output from the first and the second set of filters respectively by a first and a second detector;

generating a difference between a transformed output from the first detector and a transformed output from the second detector at an output of said difference operator;

detecting a digital word, said digital word obtained from a bit detector, wherein the input to the bit detector is the output of the difference operator;

storing the detected digital word in a buffer; and

error-correcting the stored digital word for determining the digital data.

36. The receiver according to claim 35, wherein the first set of filters includes an in-phase filter and a quadrature filter.

37. The receiver according to claim 35, wherein the second set of filters includes an in-phase filter and a quadrature filter.

38. The receiver according to claim 35, further including the step of delaying the output from the first detector by a first p-bit delay operator and delaying the output from the second detector by a second p-bit delay operator.

39. The receiver according to claim 38, wherein $p=1/2$.

40. The receiver according to claim 38, further including the step of determining the difference between the output of the first detector and an output of the first p-bit delay operator.

41. The receiver according to claim 38, further including the step of determining the difference between the output of the second detector and an output of the second p-bit delay operator.

42. The receiver according to claim 35, further including the step of obtaining a score as a function of previous values of the difference between the outputs of the first and the second detectors.

43. The receiver according to claim 42, further including the step of selecting the stored digital word for error correction if the score for said stored digital word exceeds a threshold.

44. The receiver according to claim 42, wherein the score is a sum of the previous values of the difference between the outputs of the first and the second detectors.

45. The receiver according to claim 43, further including the step of dynamically adjusting the threshold as a function of an unselected digital word.

46. A device for transmitting and receiving digital data wirelessly, the device comprising:

a transmitter including: (i) an error correction and interleaving system for introducing correction bits into the digital data to form a data sequence; (ii) an encoder for encoding the data sequence with acoustic tones to generate an encoded data sequence; (iii) an audio speaker for transmitting the encoded data sequence; and

a receiver including: (i) a microphone for capturing the encoded data sequence; (ii) a first and a second set of filters for filtering the received acoustic tones encoded by the digital data; (iii) a first and a second detector for determining the magnitude of the complex output from the first and the second set of filters respectively; (iv) a difference operator for generating a difference between the outputs of the first and the second detectors; (v) means for detecting a digital word, said digital word obtained from a bit detector, wherein the input to the bit detector is the difference between the outputs of the first and the second detectors; (vi) a buffer for storing the detected digital word; (vii) means for error correcting the stored digital word for determining the digital data.